BUILDINGENERGY BOSTON

Reaching Net Zero Carbon through Building Energy Codes

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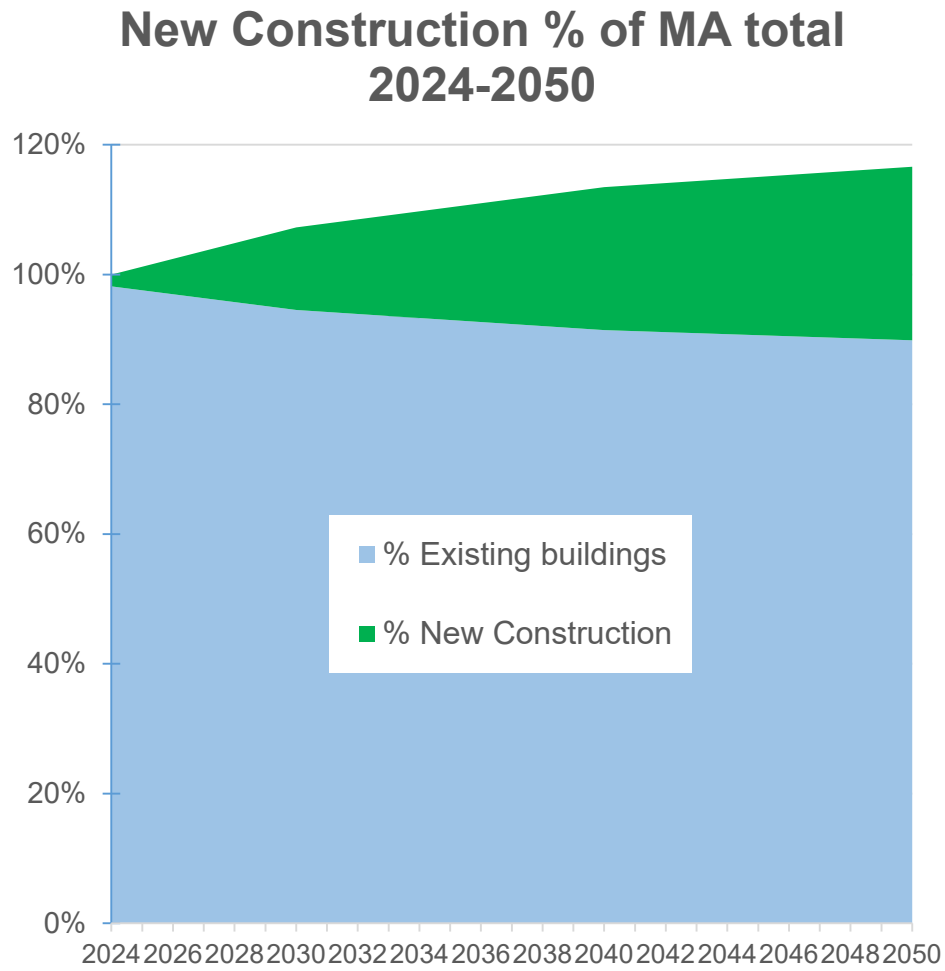
Northeast Sustainable Energy Association (NESEA)
March 28, 2023

Agenda

- Policy context
- IECC 2021
- IECC 2024
- New York State
- Massachusetts

Building Energy Code role in reducing emissions

- Building code is the primary policy impacting new buildings.
- New buildings (built after 2023) ~27% of all building space by 2050
- New buildings are easiest and cheapest to make 2050-compliant
- New construction market helps drive cost reductions in building retrofits.
- 2030: Massachusetts legal limit is at least 50% reduction in GHG from 1990



Policy Goals for Building Energy Code

- Low cost GHG emissions reductions
  - Start with Energy Efficiency
    - All cost-effective required by 2008 Green Communities Act for Stretch code
  - Incentivize Electrification of remaining heating load
  - Mitigate peak electric loads to minimize grid infrastructure costs
- Plan for future infrastructure needs
  - EV ready and Solar ready across all energy codes
  - All-Electric ready pre-wiring in the Specialized code
- Allow Cities and Towns to adopt on their timeline
  - Base, Stretch and Specialized codes – 3 options for municipalities
  - Separate 10 community fossil-fuel free demonstration program

2021 IECC

Reasons for adopting 2021 IECC

Compliance Pathways

Air Leakage Testing

Reasons for adopting 2021 IECC

Energy Efficiency Improvements

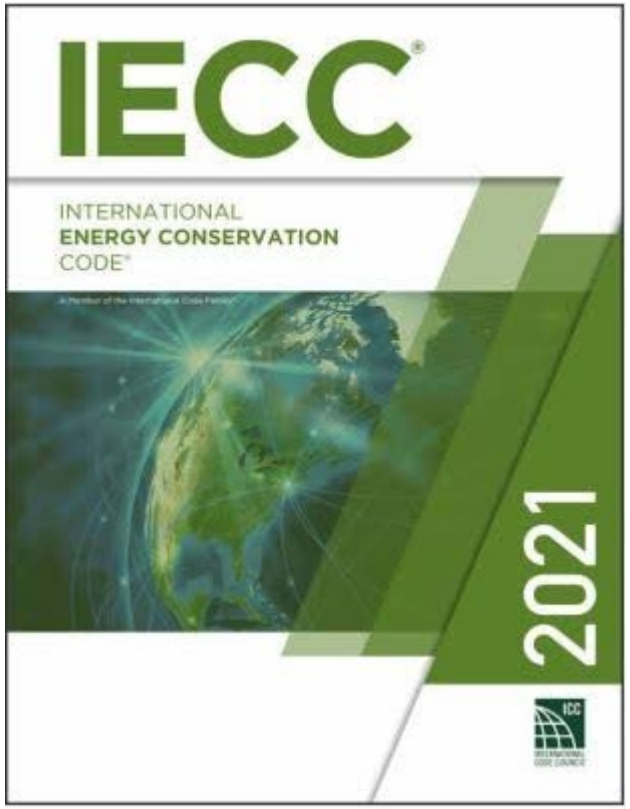
- 40% over 2006 IECC
- 9.4% more efficiency and 8.7% less GHG - 2018 IECC
- over 700 million metric tons (MMT) of Co2 savings

Resilience Benefits

- Improving envelope efficiency saves lives during extreme temperature events.

Improve usability

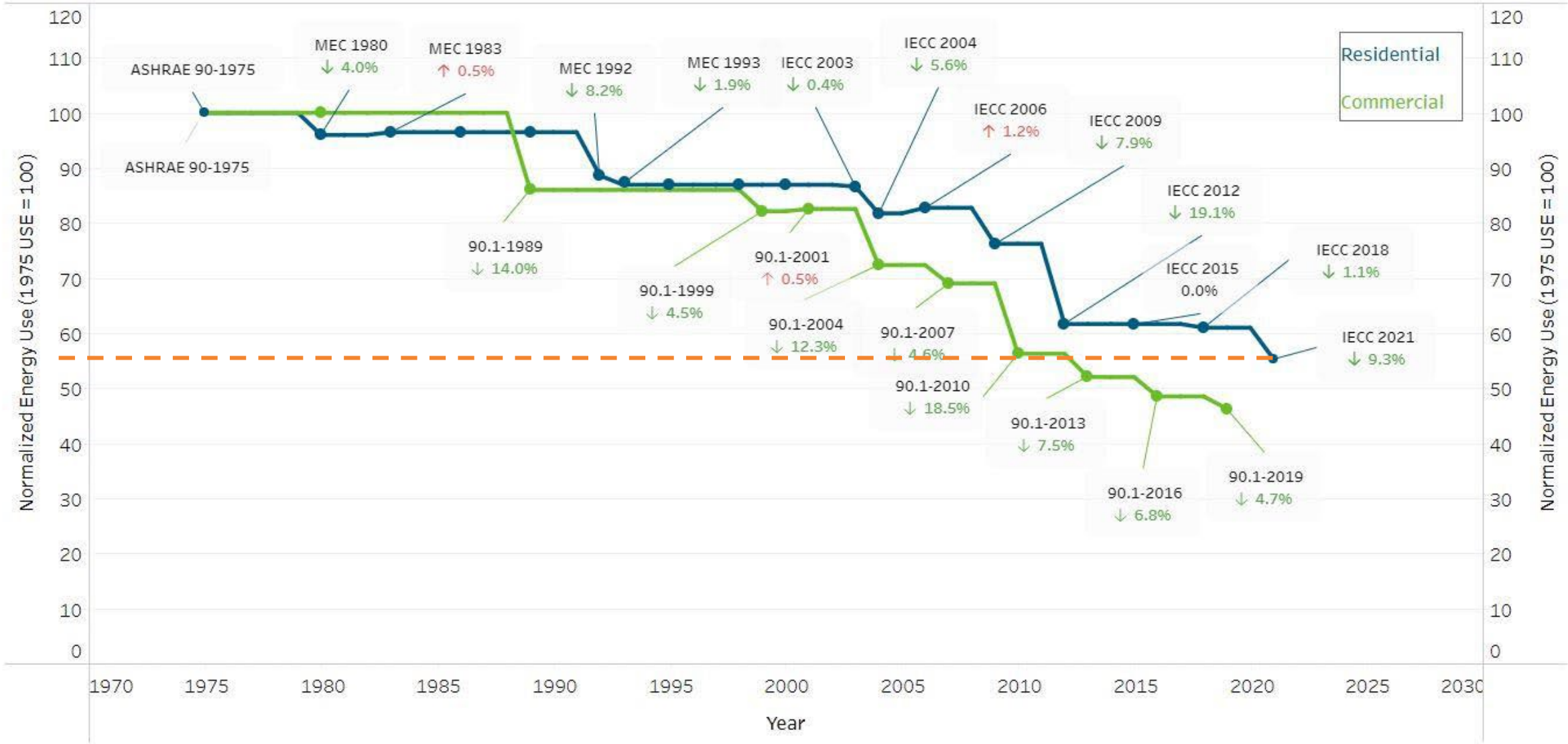
- Encourage flexibility in design and construction
- provide clarification and improve the usability of the code



U.S. DEPARTMENT OF ENERGY

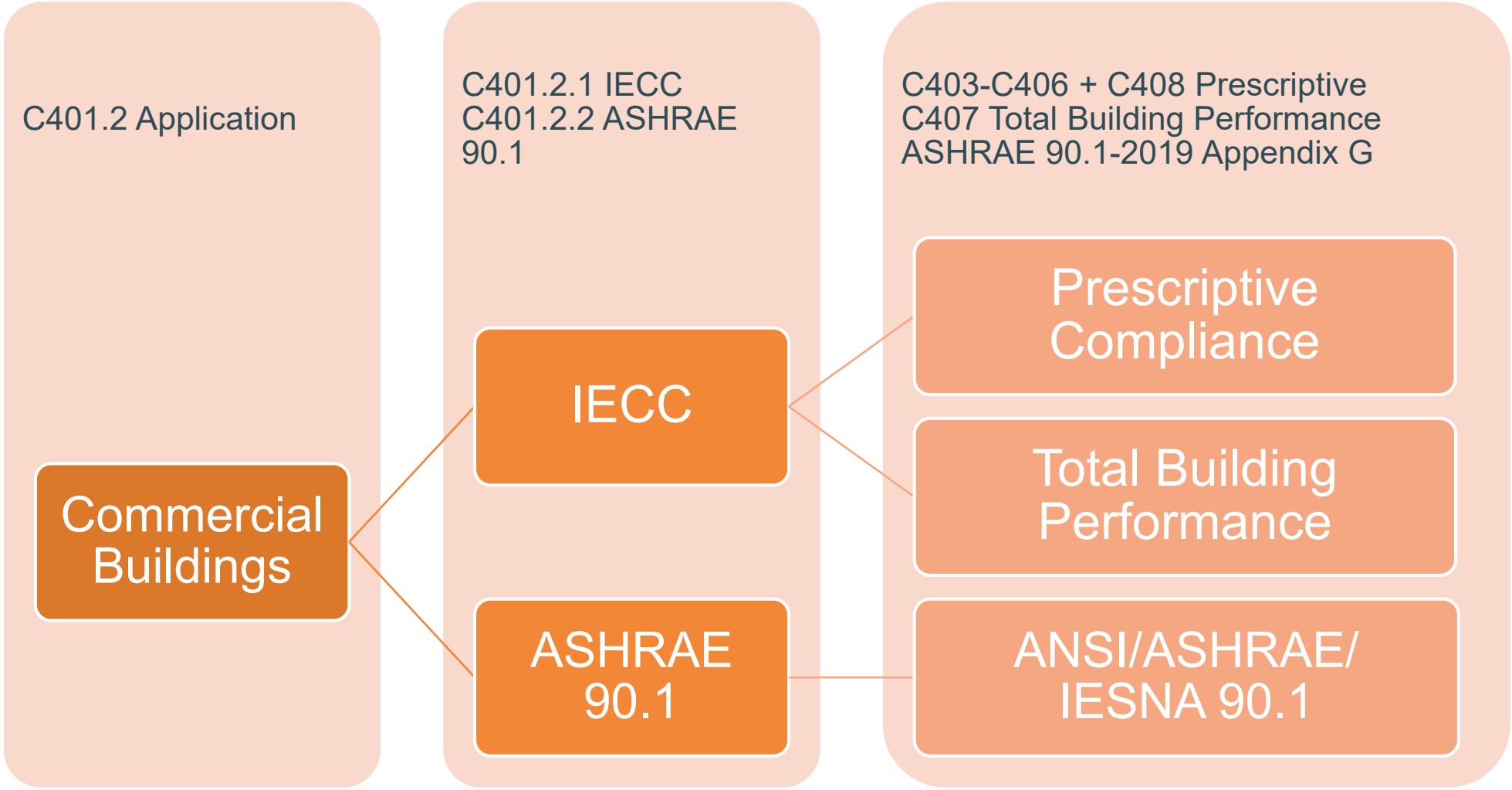
Estimated Improvement in Residential & Commercial Energy Codes
(1975 - 2021)

Pacific Northwest NATIONAL LABORATORY



Compliance Pathways

Commercial



Compliance Pathways

Commercial

C403-C406 + C408 Prescriptive

Prescriptive Compliance

Compliance Pathways

Commercial

C402	• Building Envelope Requirements
C403	• Building Mechanical Systems
C404	• Service Water Heating
C405	• Electrical Power and Lighting Systems
C406	• Additional Efficiency Requirements
C408	• Maintenance Information and system commissioning

C403-C406 + C408 Prescriptive

Prescriptive Compliance

Compliance Pathways

Commercial

- **C402** • Building Envelope Requirements
- **C403** • Building Mechanical Systems
- **C404** • Service Water Heating
- **C405** • Electrical Power and Lighting Systems
- **C406** • Additional Efficiency Requirements
- **C408** • Maintenance Information and system commissioning

C403-C406 + C408 Prescriptive

Prescriptive Compliance

10 credits calculated per Section C406 Tables C406.1(1) - C406.1(5) based on the use of the building

NEW

Compliance Pathways

Commercial

C406 • Additional Efficiency Requirements

10 credits calculated per Section C406 Tables C406.1(1) - C406.1(5) based on the use of the building

NEW

1. **More efficient HVAC performance**
   in accordance with Section C406.2
2. **Reduced lighting power**
   in accordance with Section C406.3
3. **Enhanced lighting controls**
   in accordance with Section C406.4
4. **On-site supply of renewable energy**
   in accordance with Section C406.5
5. **Dedicated outdoor air system**
   for certain HVAC equipment in accordance with Section C406.6
6. **High-efficiency service water heating**
   in accordance with Section C406.7
7. **Enhanced envelope performance**
   in accordance with Section C406.8
8. **Reduced air infiltration**
   in accordance with Section C406.9
9. **Energy monitoring system**
   where not required by Section C405.12, in accordance with Section C406.10
10. **Fault detection and diagnostics (FDD)**
    where not required by Section C403.2.3, system in accordance with Section C406.11
11. **Efficient kitchen equipment**
    in accordance with Section C406.12

TABLE C406.1(1)
ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% cooling efficiency improvement	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% cooling efficiency improvement	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced lighting power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: On-site renewable energy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: Dedicated outdoor air	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.8: Enhanced envelope performance	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced air infiltration	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6
C406.10: Energy monitoring	4	4	4	4	3	3	3	3	3	3	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

TABLE C406.1(1)
ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% cooling efficiency improvement	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% cooling efficiency improvement	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced lighting power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: On-site renewable energy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: Dedicated outdoor air	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.8: Enhanced envelope performance	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced air infiltration	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6
C406.10: Energy monitoring	4	4	4	4	3	3	3	3	3	3	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

TABLE C406.1(1)
ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

SECTION	CLIMATE ZONE															
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% cooling efficiency improvement	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% cooling efficiency improvement	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced lighting power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: On-site renewable energy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: Dedicated outdoor air	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.8: Enhanced envelope performance	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced air infiltration	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6
C406.10: Energy monitoring	4	4	4	4	3	3	3	3	3	3	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

Compliance Pathways

Commercial

C407 Total Building Performance

Total Building Performance

Compliance Pathways

Commercial

C407 Total Building Performance

Table C407.2	• Requirements of sections listed
Model	• Energy cost =< 85% reference design

Total Building Performance

Compliance Pathways

Commercial

Units in Group R-2 buildings can comply through the Residential Energy Rating Index option (R406)

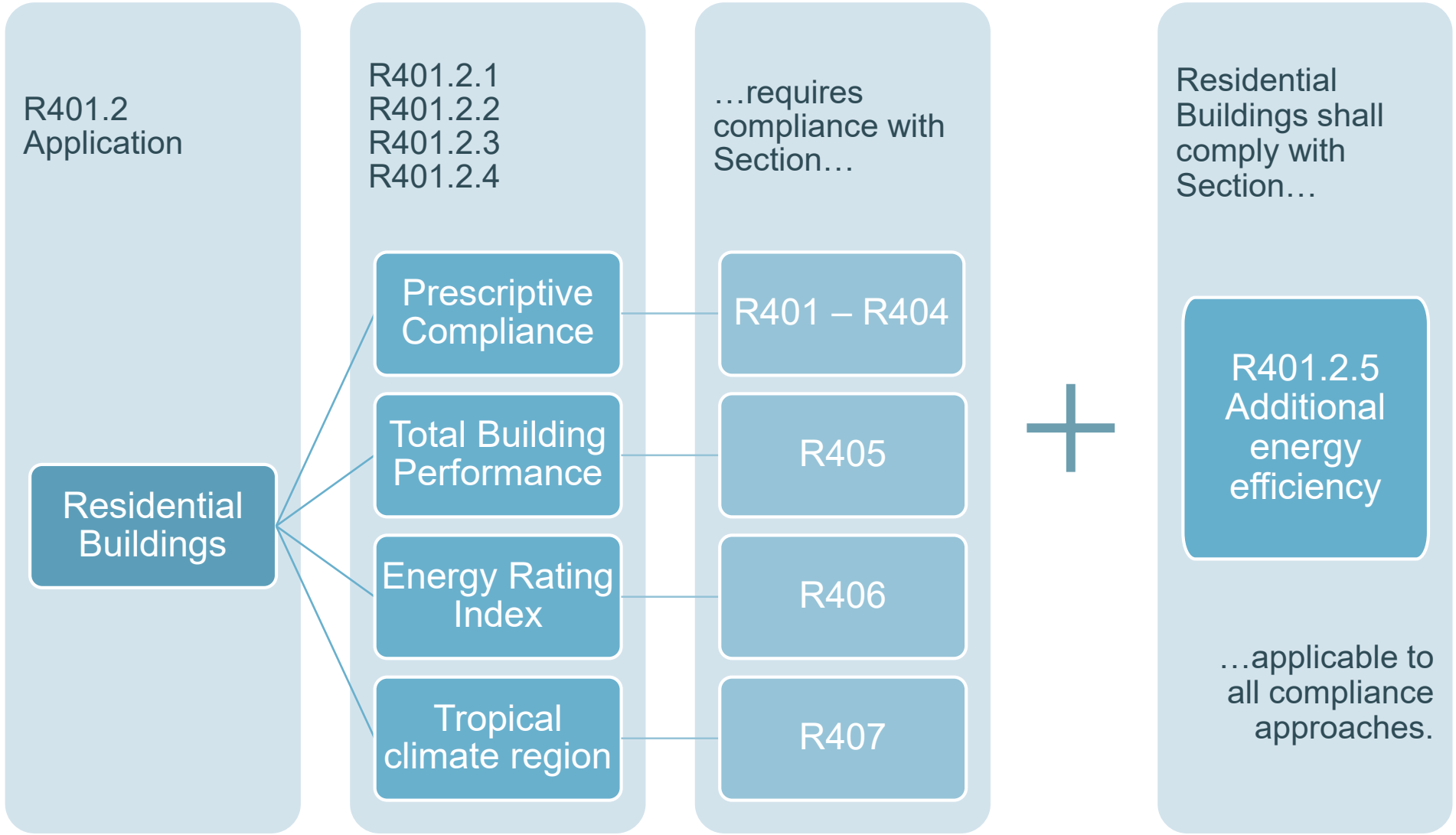
Table C407.2	• Requirements of sections listed
Model	• Energy cost =< 85% reference design

C407 Total Building Performance

Total Building Performance

Compliance Pathways

Residential



Compliance Pathways

Residential

Residential Buildings shall comply with Section…

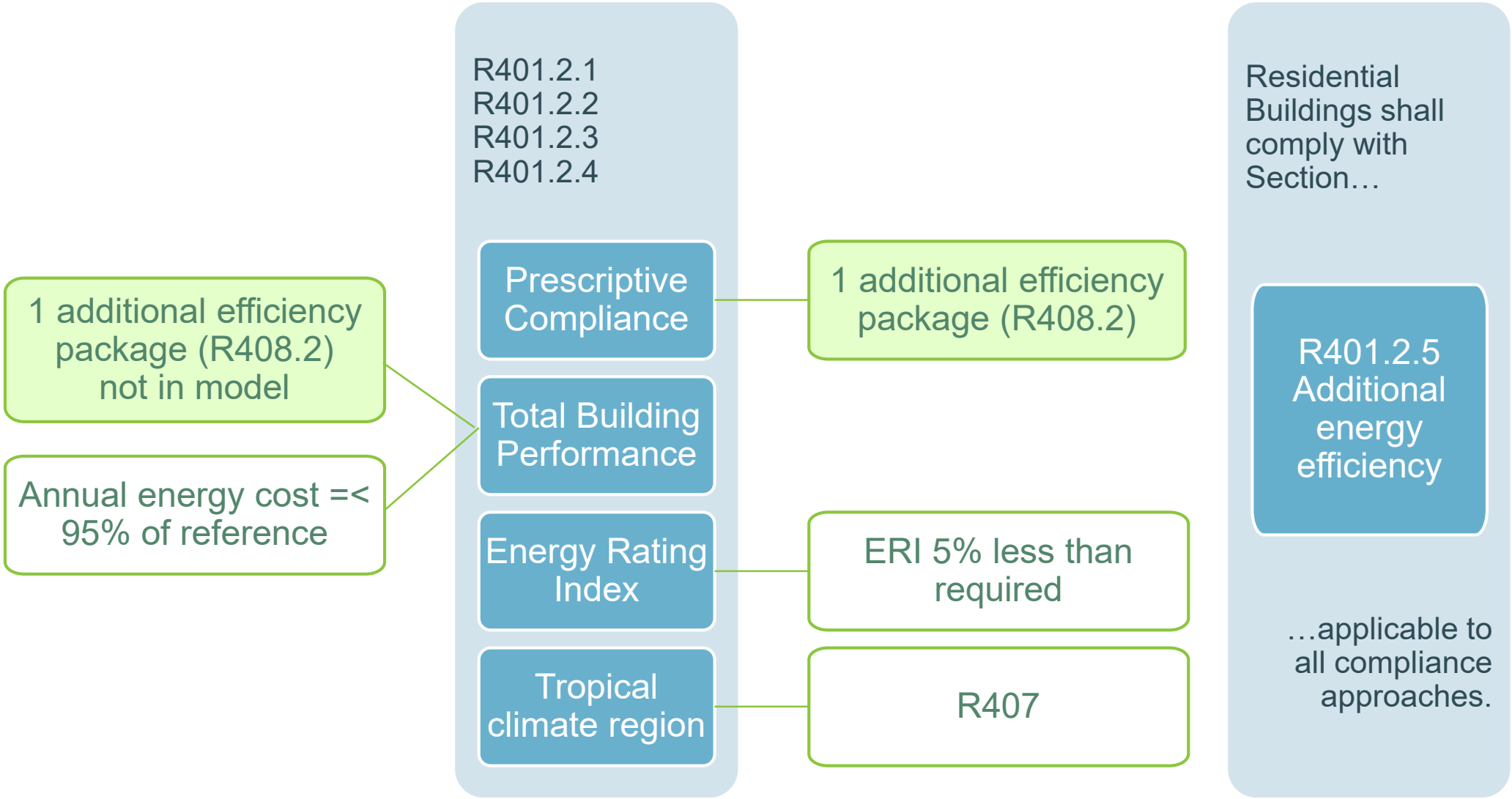
NEW

R401.2.5 Additional energy efficiency

…applicable to all compliance approaches.

Compliance Pathways

Residential



Compliance Pathways

Residential

R408.2 Additional Efficiency Package Options

R408.2.1	• Enhanced envelope performance option
R408.2.2	• More efficient HVAC equipment performance option
R408.2.3	• Reduced energy use in service water-heating option
R408.2.4	• More efficient duct thermal distribution system option
R408.2.5	• Improved air sealing and efficient ventilation system option

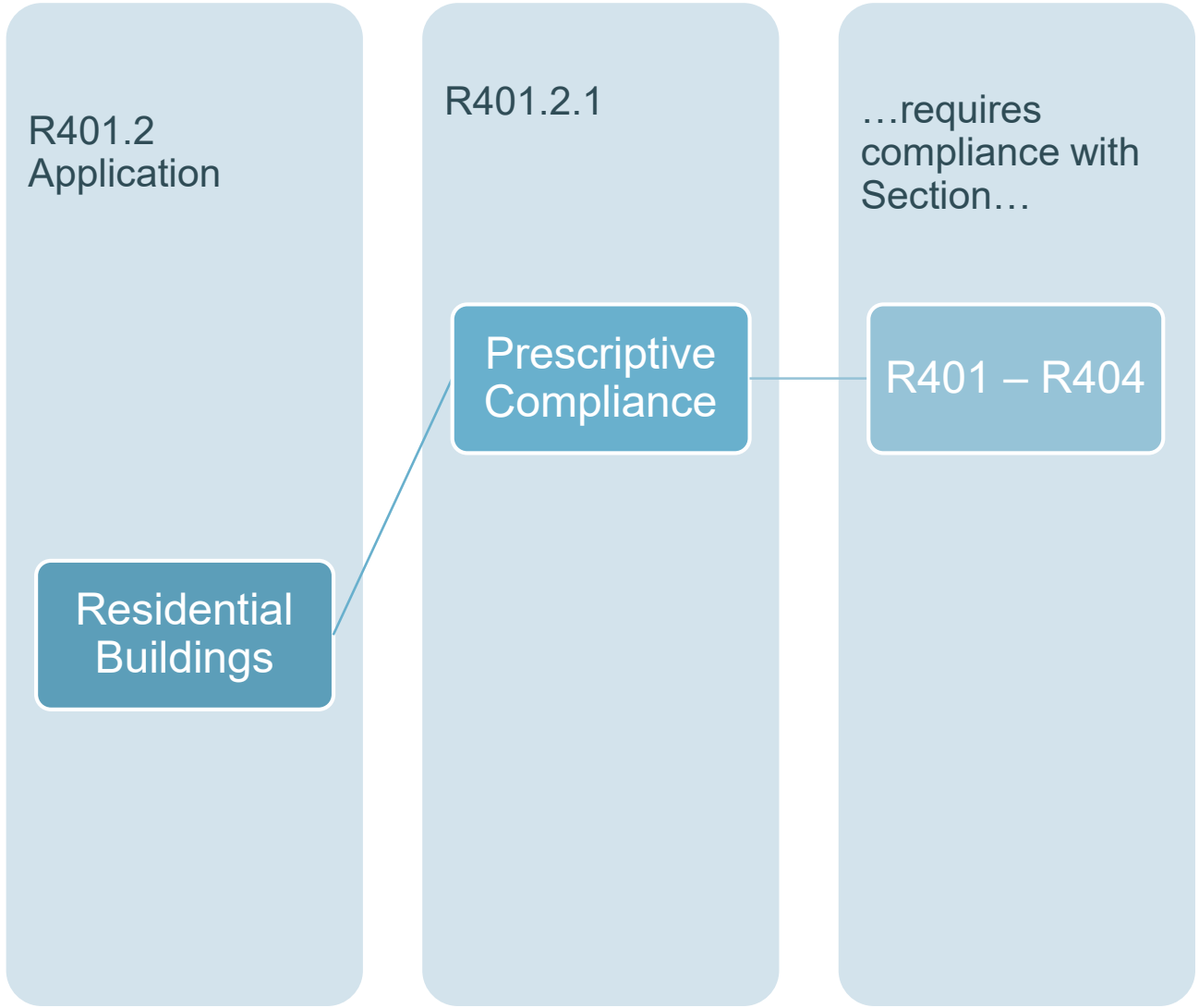
Residential Buildings shall comply with Section…

R401.2.5 Additional energy efficiency

…applicable to all compliance approaches.

Compliance Pathways

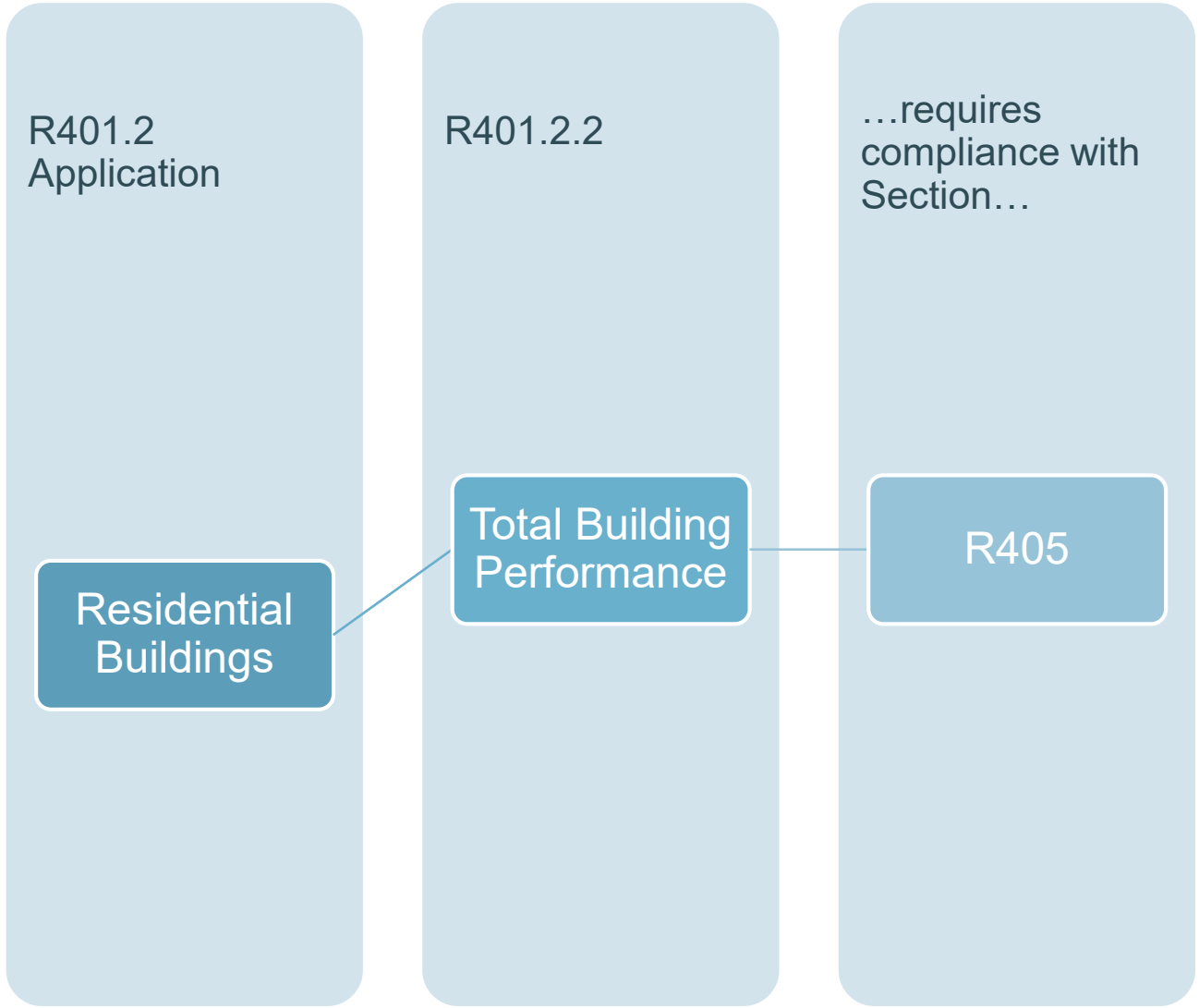
Residential



R401	• General
R402	• Building Thermal Envelope
R403	• Systems
R404	• Electrical Power and Lighting Systems

Compliance Pathways

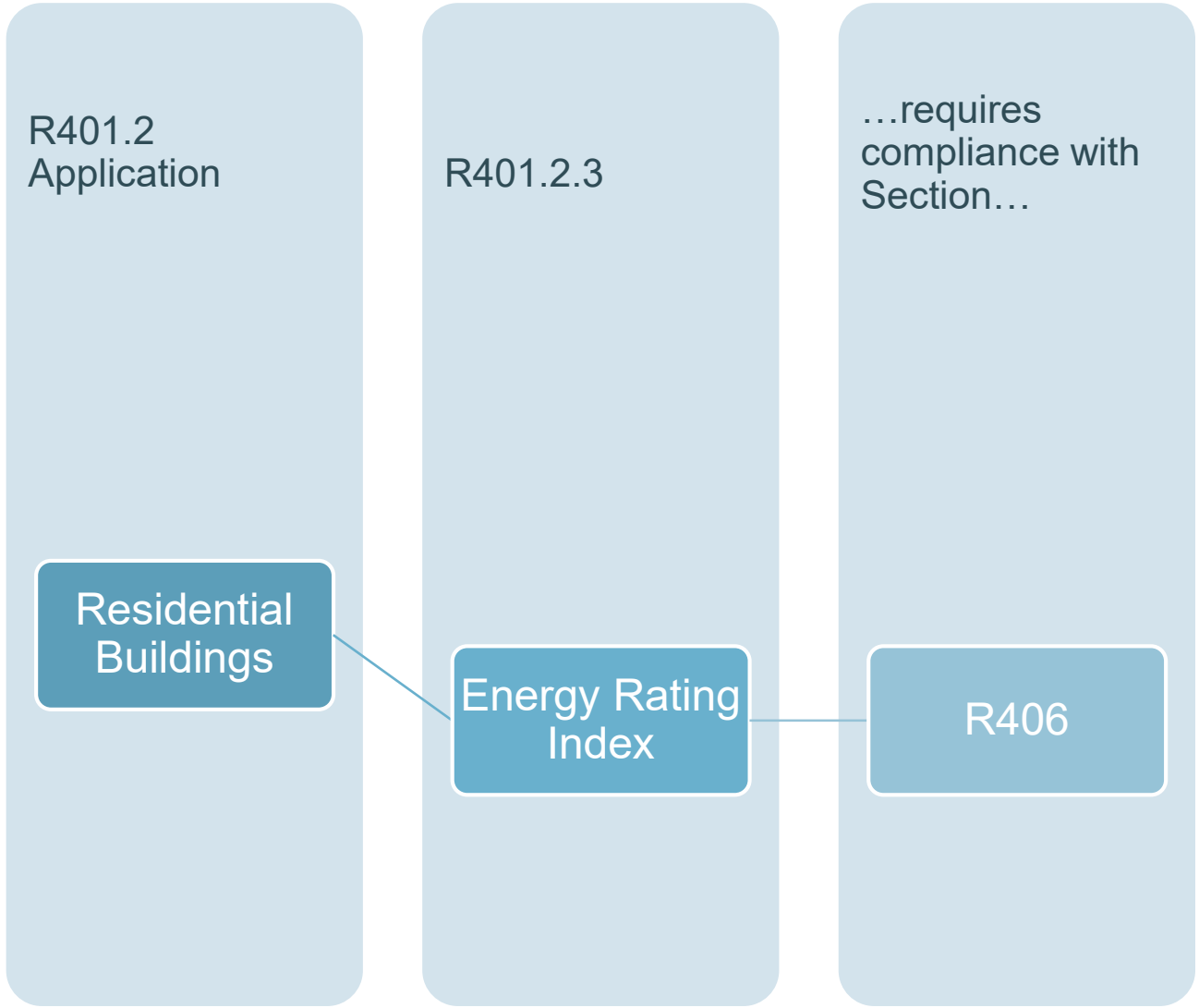
Residential



- The requirements of the sections indicated within Table R405.2
- Envelope =>efficiency and SHGC, Table R402.1.1 or R402.1.3 of 2009 IECC
- Annual energy cost =< reference design

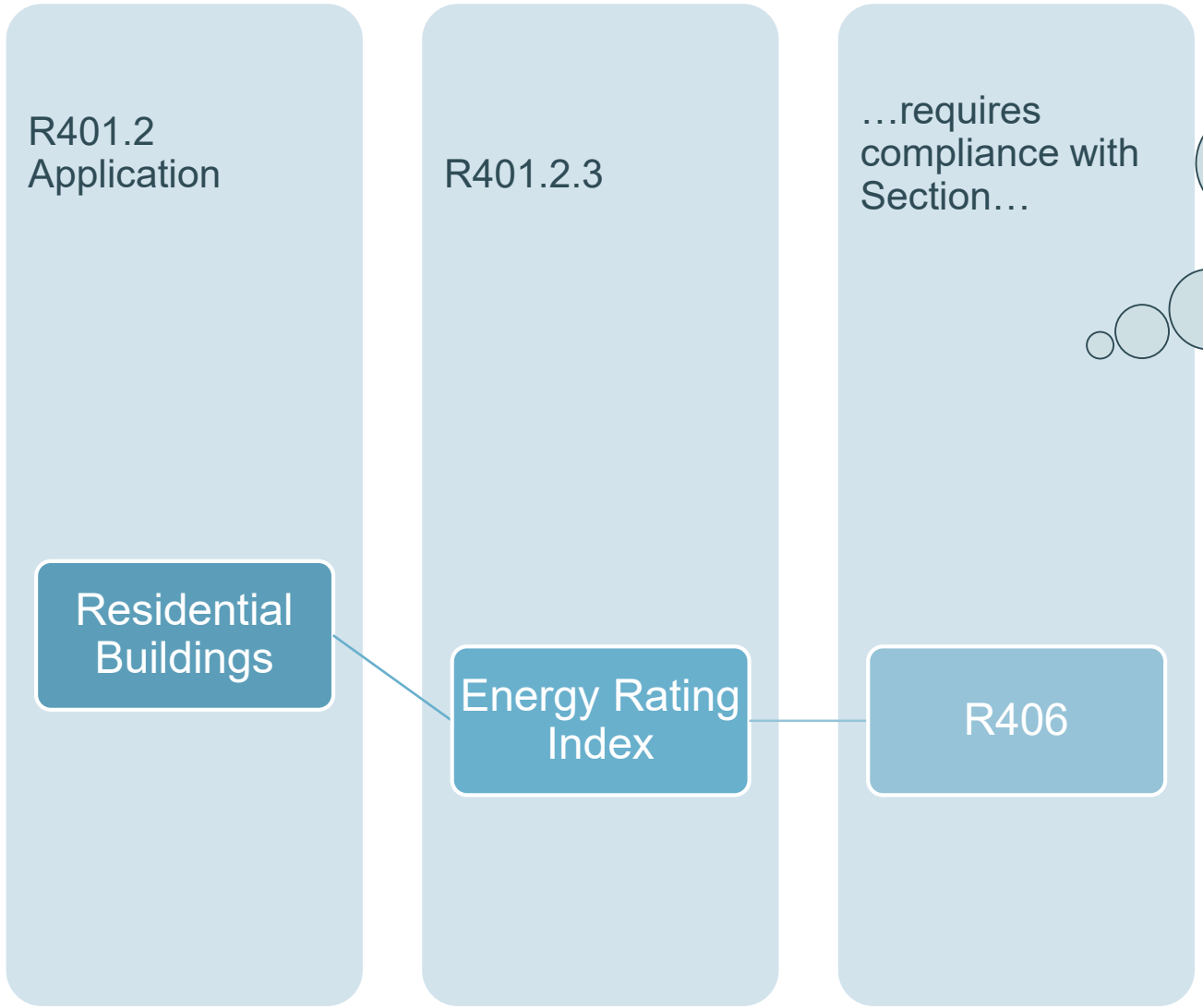
Compliance Pathways

Residential



Compliance Pathways

Residential



Units in Group R-2 buildings can comply through the Residential Energy Rating Index option (R406)

- The requirements of the sections indicated within Table R406.2

- Maximum ERI of Table R406.5
- Range 51-55 depending on CZ. CZ5: 55

NEW

Air Leakage Testing

Commercial

Three ways to comply with the Air Barrier Requirements

1

C402.5.2

Dwelling and sleeping unit enclosure testing

Except

CZ 2B, 3C and 5C

2

C402.5.3

Building thermal envelope testing

Except

CZ 2B, 3B, 3C,5C

> 5,000 ft^2 in CZ 0B, 1, 2A, 4B, 4C

5,000 - 50,000 ft^2 in CZ 0A,3A,5B

3

If no air barrier testing

C402.5.1.5 Building envelope performance verification

+

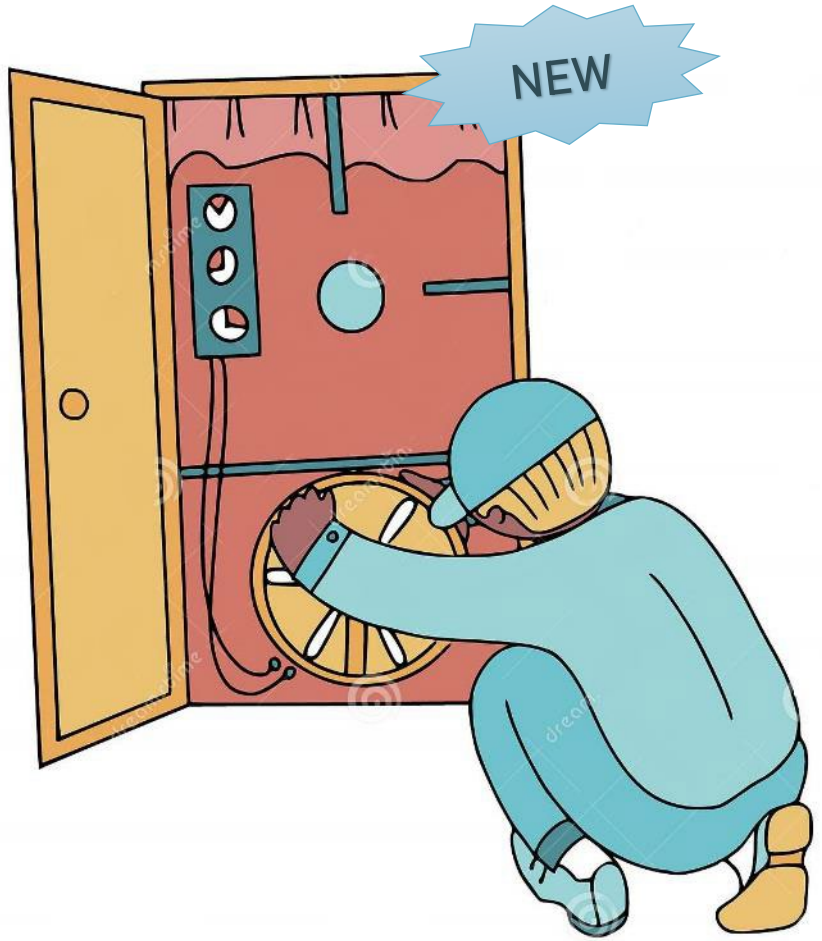
C402.5.1.3 Materials

OR

C402.5.1.4 Assemblies

Air Leakage Testing

Commercial



1

C402.5.2

Dwelling and sleeping unit enclosure testing

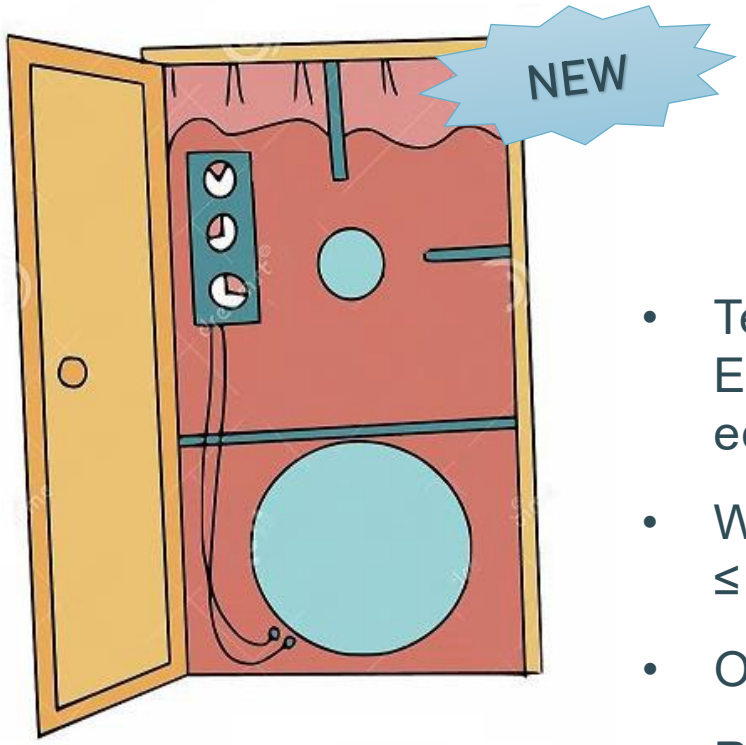
Except

CZ 2B, 3C and 5C

- ASTM E779 or E1827, ANSI 380, or equivalent
- air leakage is ≤ 0.30 cfm50/ft^2
- weighted average of all results
- Dwelling units tested separately
- < 8 units – test all
- > 8 units – sampling allowed

Air Leakage Testing

Commercial



- Test in accordance with ASTM E779, E3158 or E1827, or equivalent method
- Whole-building air leakage ≤ 0.40 cfm75/ft^2
- Or, portions of the building
- Requirements on how to select portions of the building

2

C402.5.3

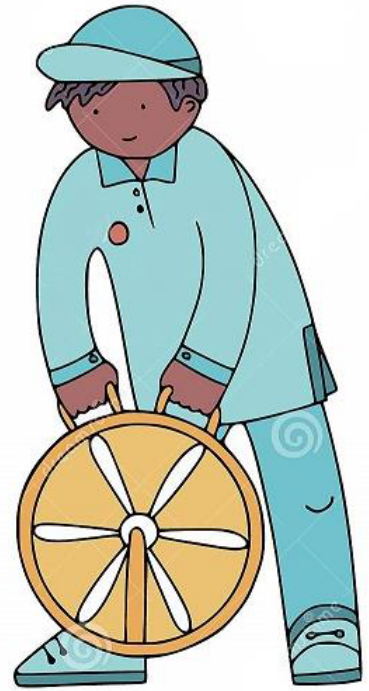
Building thermal envelope testing

Except

CZ 2B, 3B, 3C,5C

> 5,000 ft^2 in CZ 0B, 1, 2A, 4B, 4C

5,000 - 50,000 ft^2 in CZ 0A,3A,5B



2021 IECC Zero Code Appendix

- Optional for jurisdictions to adopt
- Compliance with 2021 IECC required
- Enough on-site or off-site renewable energy to compensate for any energy consumption
- Residential Based on the ERI path with more efficiency required
- Commercial based on Architecture2030 ZERO Code

ZERO CODE™

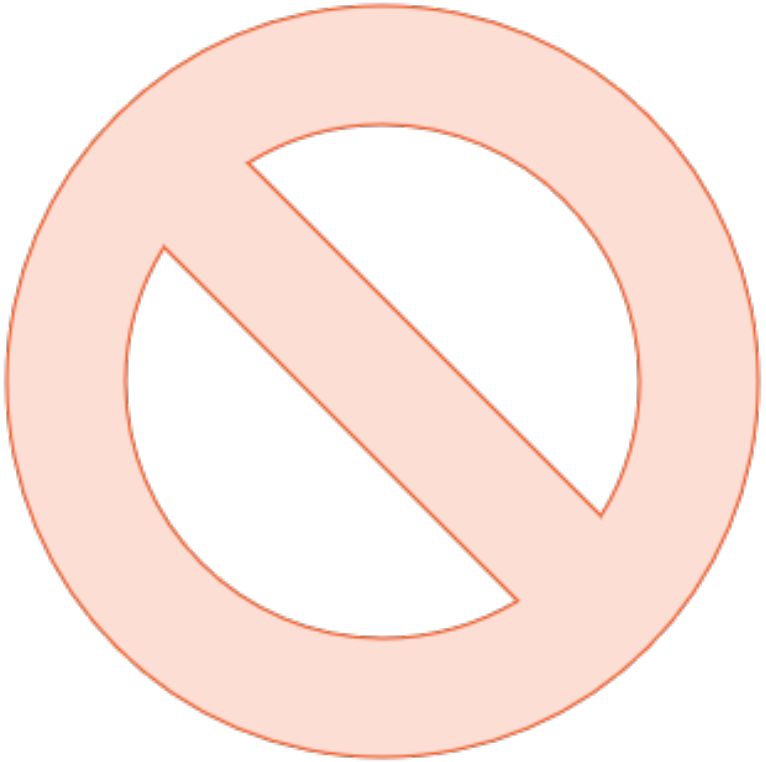
2024 IECC

Update on the Development
What's NOT in the 1st Draft
Progresses & Requirements

2024 IECC

Update on the Development

What's NOT in the 1st draft



- A ban on the use of fossil fuels
- Embodied carbon accounting
- Mandate for solar PV
- Mandate for electric EV chargers

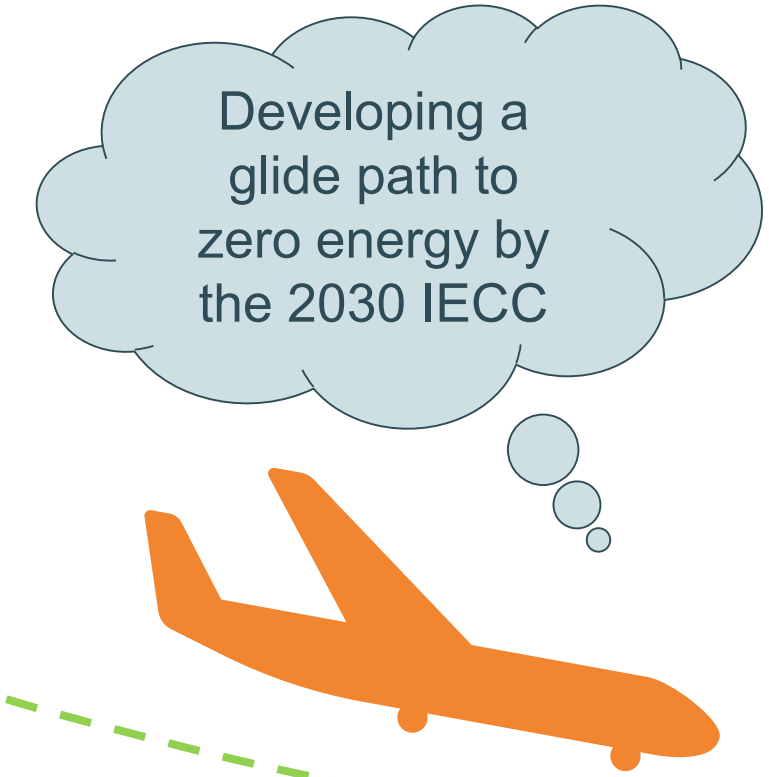
Progress & Requirements

Roughly 6-7% energy savings

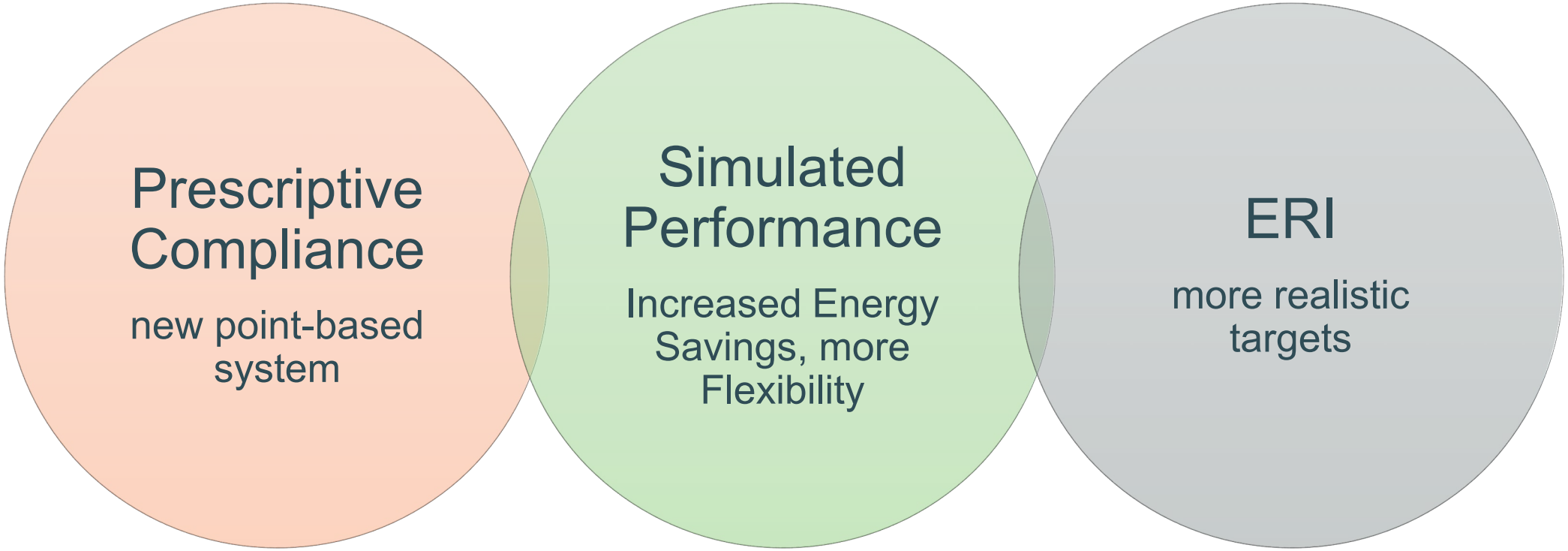
New requirements

Increasing stringency

Compliance pathways to achieve similar performance



Compliance Pathways



- 10 points
- Improve Additional Efficiency Package Options
- onsite renewable

- Increased savings
- credit for HVAC, DHW efficiency, and duct location
- rigorous envelope backstop

- more parity with other paths
- HERS Index in the low 50s
- on-site renewables, if a lower ERI is met

Areas of “readiness”

Required regardless of compliance path

Solar Readiness

Demand-response DHW

Electric Readiness

Electric Vehicle Readiness

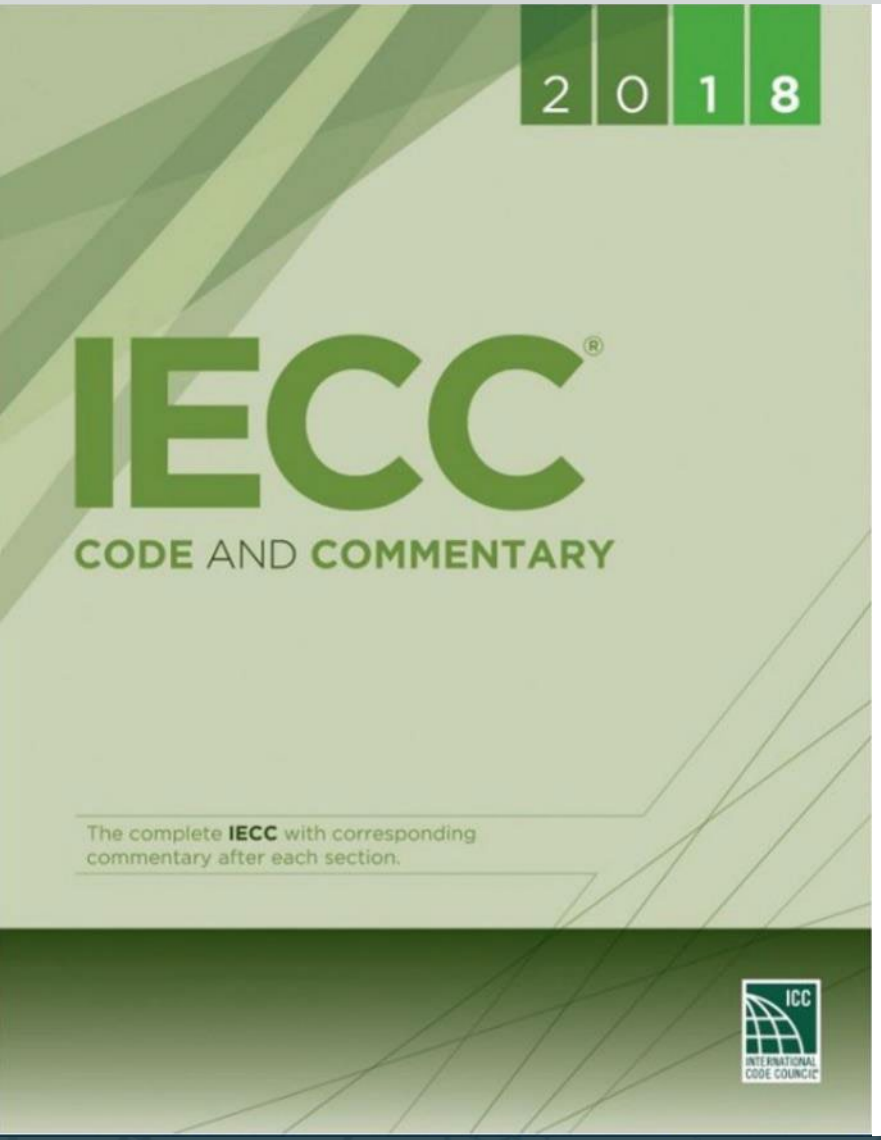
NYS

New York State Energy Code

New York State Stretch Code

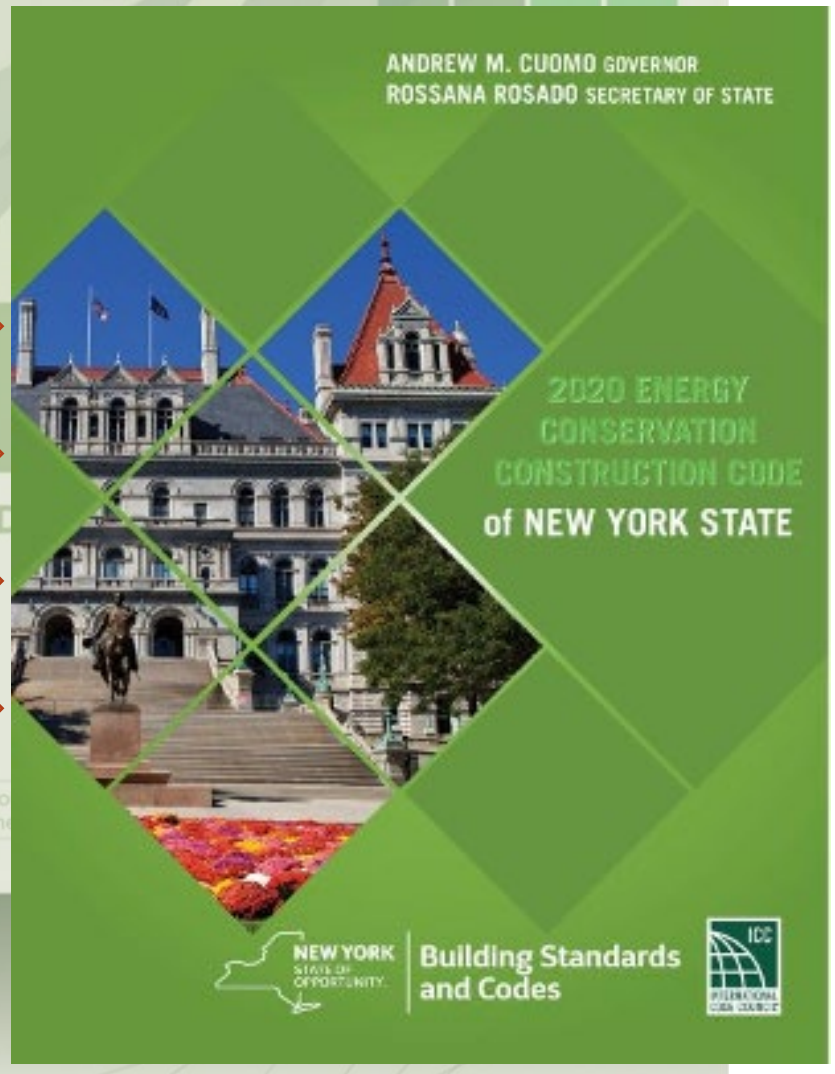
New York City Energy Code

2020 Energy Conservation Construction Code of New York State



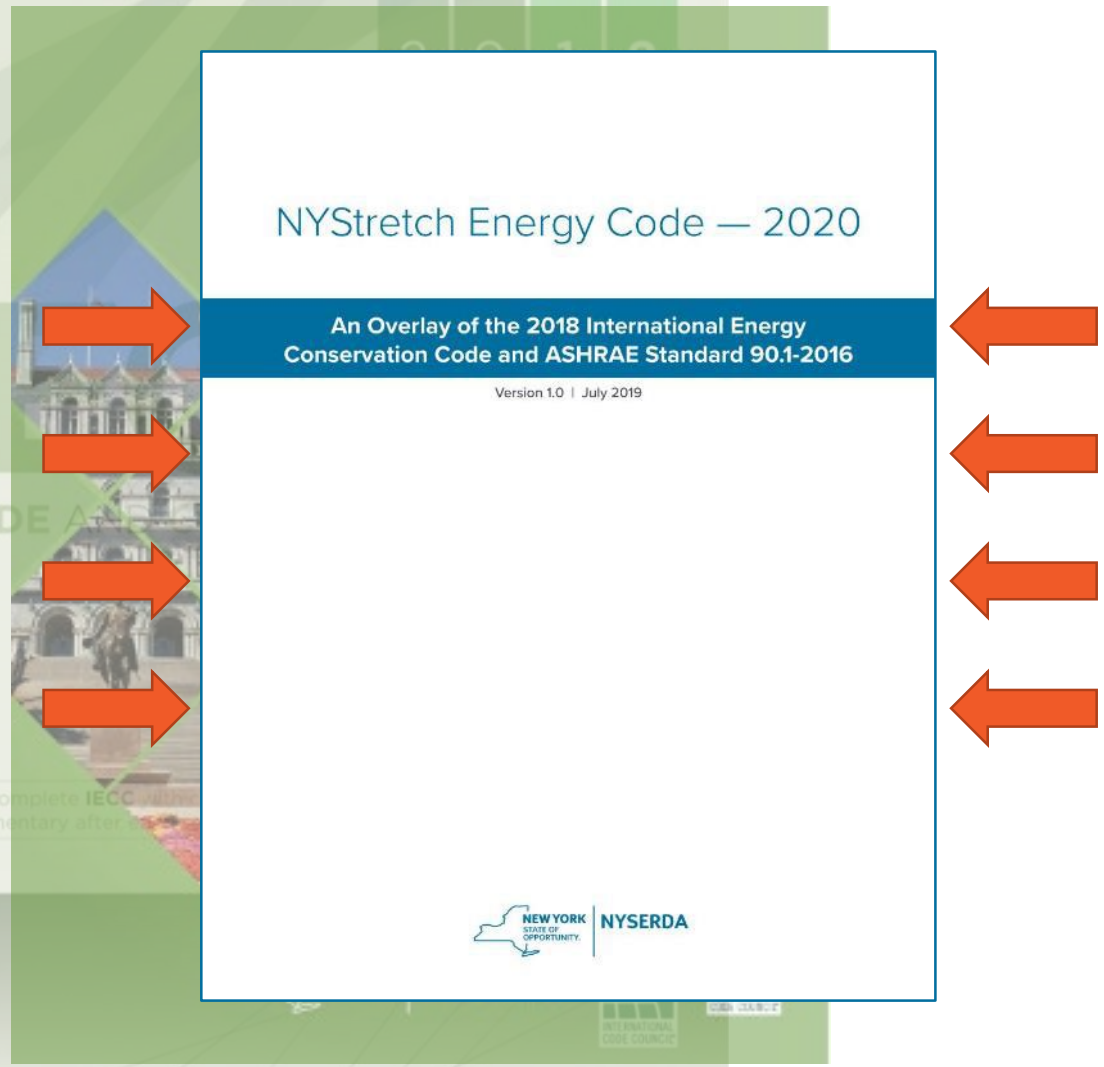
- New York State currently adopts 2018 IECC

2020 Energy Conservation Construction Code of New York State



- New York State currently adopts 2018 IECC
- 2020 ECCCNYS is based on
  - 2018 IECC and ASHRAE 90.1-2016 for Commercial
  - 2018 IECC for Residential
- Effective date: 05/12/2020
- Includes State Amendments
- Enforcement is mandatory statewide.

NYStretch Energy Code 2020



- NYStretch-2020 is an overlay of the 2018 IECC and ASHRAE 90.1-2016. Supplement of the 2020 ECCCNYS.
- Improve State by roughly 10%
- Developed by NYSERDA
- For voluntary adoption by local governments as a more stringent local energy code
- Benefits:
  - Readily adoptable, enforceable language, familiar to building departments
  - Intended to be about one cycle ahead of the current State Energy Code
  - Cost-effective and regionally appropriate

2020 New York City Energy Conservation Code

- 2020 NYCECC adopted as Local Law 048 of 2020.
- Based on 2020 ECCCNYS
- Aligns with NYStretch-2020:
  - Continuous insulation for balconies and parapets
  - Supply ventilation with ERV/HRV for homes and multifamily 3 stories or less
  - More efficient lighting power reqs.
  - Additional lighting controls
  - ++thermal envelope reqs.
  - Source energy as a metric
  - Efficient service water heating distribution system design
  - Whole building energy monitoring
  - Efficiency for elevators and commercial kitchen equipment
  - Electric vehicle chargers

Massachusetts

Base Code

Stretch Code

Specialized Code

Base, Stretch, and Specialized – 3 Options

Base Code (IECC 2021)

- **51 communities**

10th Edition MA code from BBRS:

Effective date: Estimate Jan 2024

Stretch Code (2023 update)

- **300 communities**

Effective dates:

Residential : Jan 2023

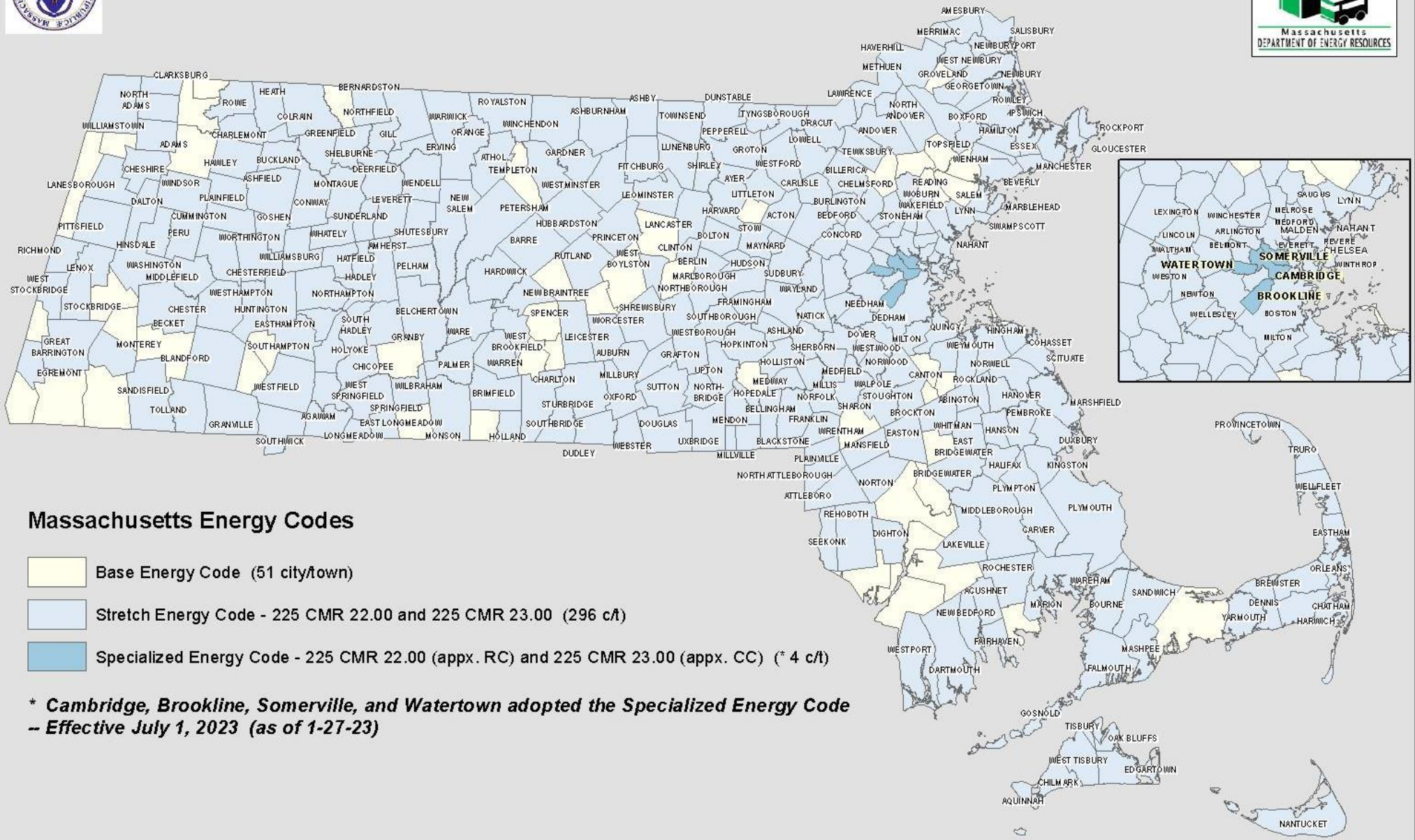
Commercial: July 2023

Specialized Code ("Net-Zero")

- **5 communities** (to date)
- **Effective date: Jan 1st or July 1st**

Recommend 6-11 months after Town/City vote

Massachusetts Building Energy Code Adoption by Municipality



Massachusetts Energy Codes

- Base Energy Code (51 city/town)
- Stretch Energy Code - 225 CMR 22.00 and 225 CMR 23.00 (296 c/t)
- Specialized Energy Code - 225 CMR 22.00 (appx. RC) and 225 CMR 23.00 (appx. CC) (* 4 c/t)

**** Cambridge, Brookline, Somerville, and Watertown adopted the Specialized Energy Code -- Effective July 1, 2023 (as of 1-27-23)***

MA DOER, 2-2-2023, jpfister

Timeline: Stretch code update

Jan 1, 2023

- **Residential update (>4 stories)**
  HERS 52/55/58

July 1, 2023

- **Commercial and Multi-family update**

July 1, 2024

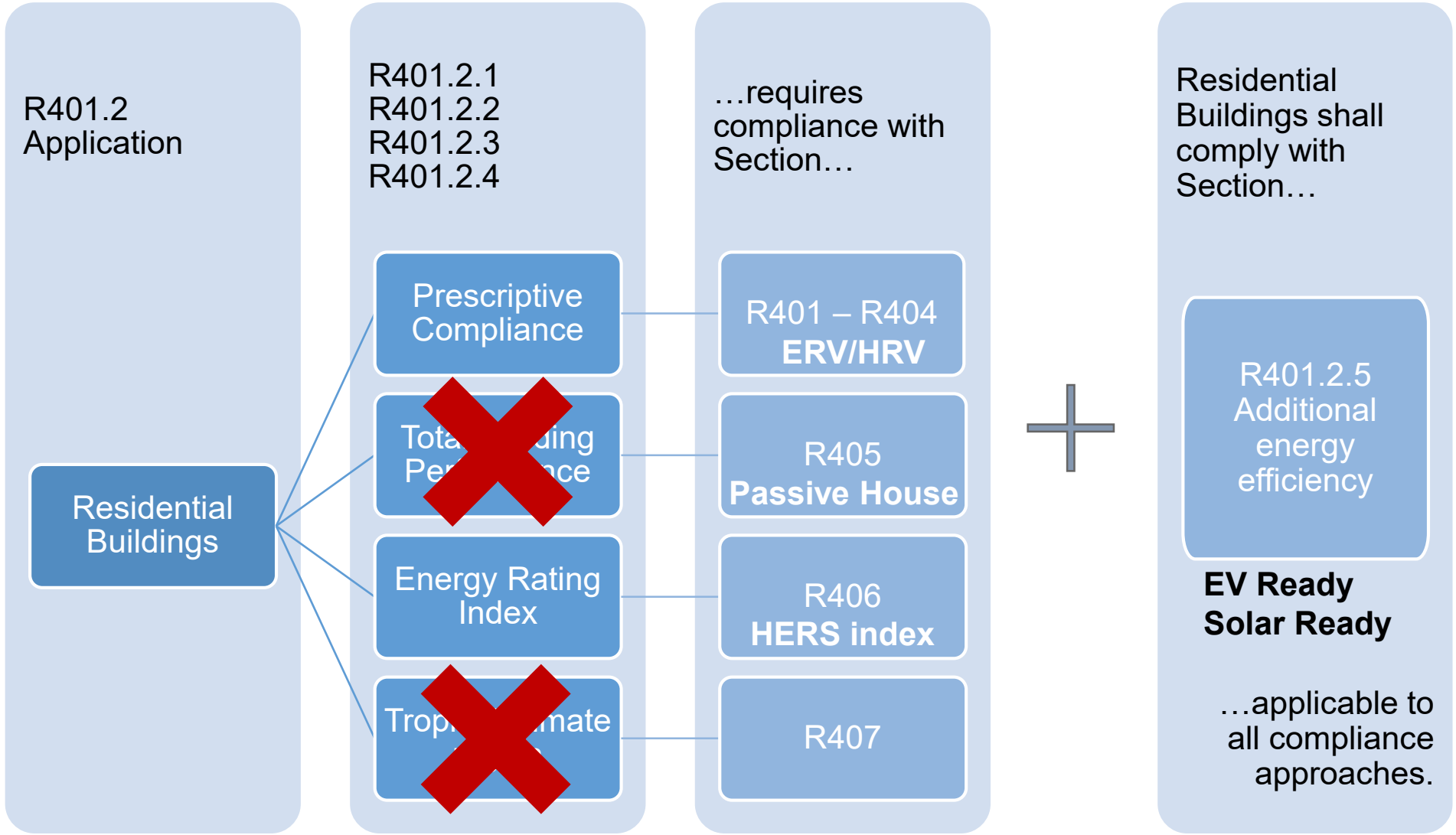
- **Residential & Multi-family update**
  HERS 42/45 or TEDI or Passive house options

Stretch code updates in 2023

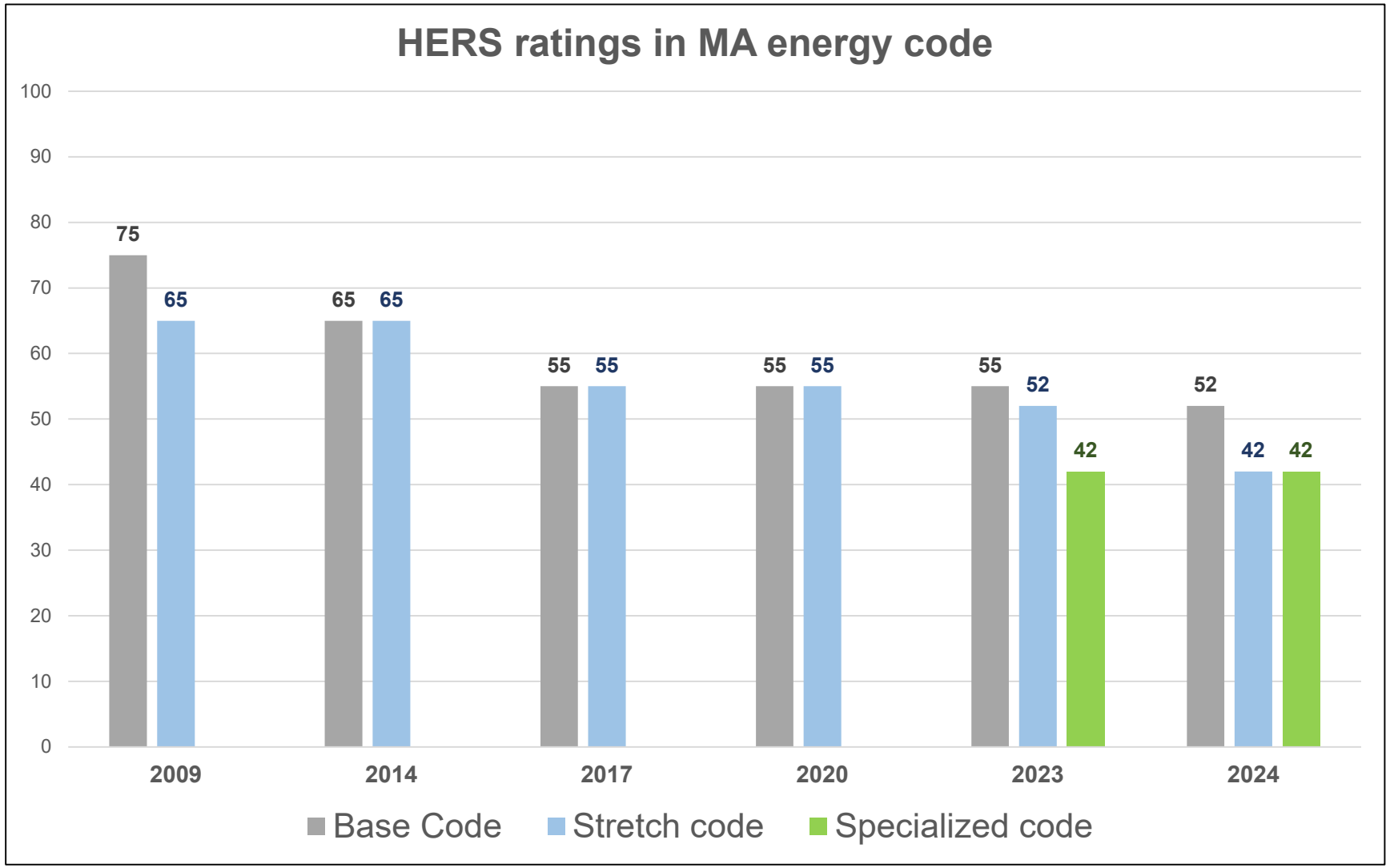
HERS rating levels lowered – July 2024

Compliance Pathways – MA Stretch code

Residential

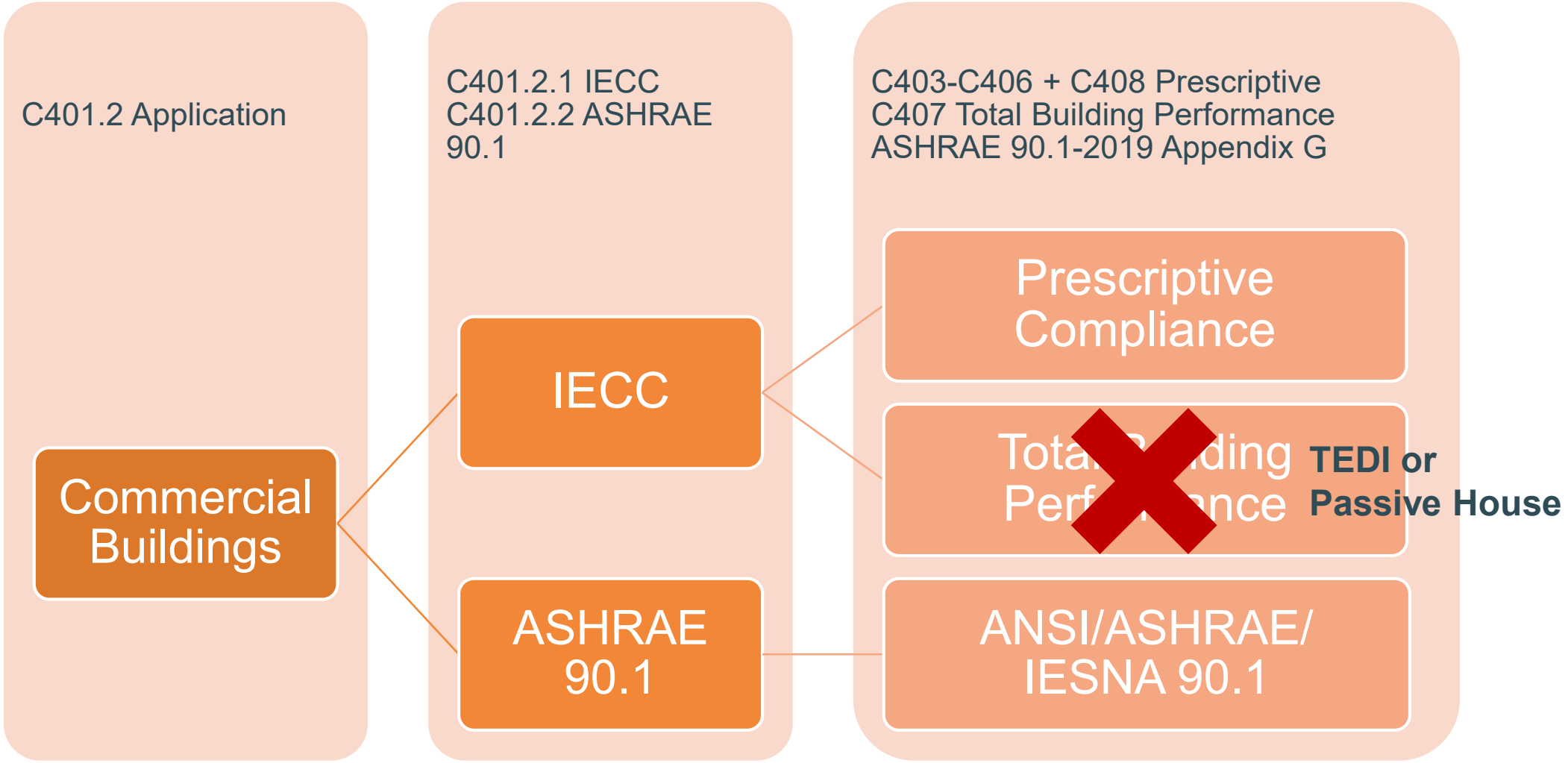


(Simplified) **History of HERS ratings in MA energy code**



Compliance Pathways

Commercial



Thermal Energy Demand Intensity (TEDI)

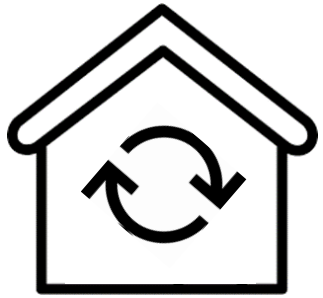
Stretch code now directly regulates heating and cooling demand for office, muni buildings, schools, and residential buildings:

Heating TEDI

*Total annual energy **delivered to** the building for space conditioning and conditioning of ventilation air, normalized by area (kBtu/sf-yr)*

Cooling TEDI

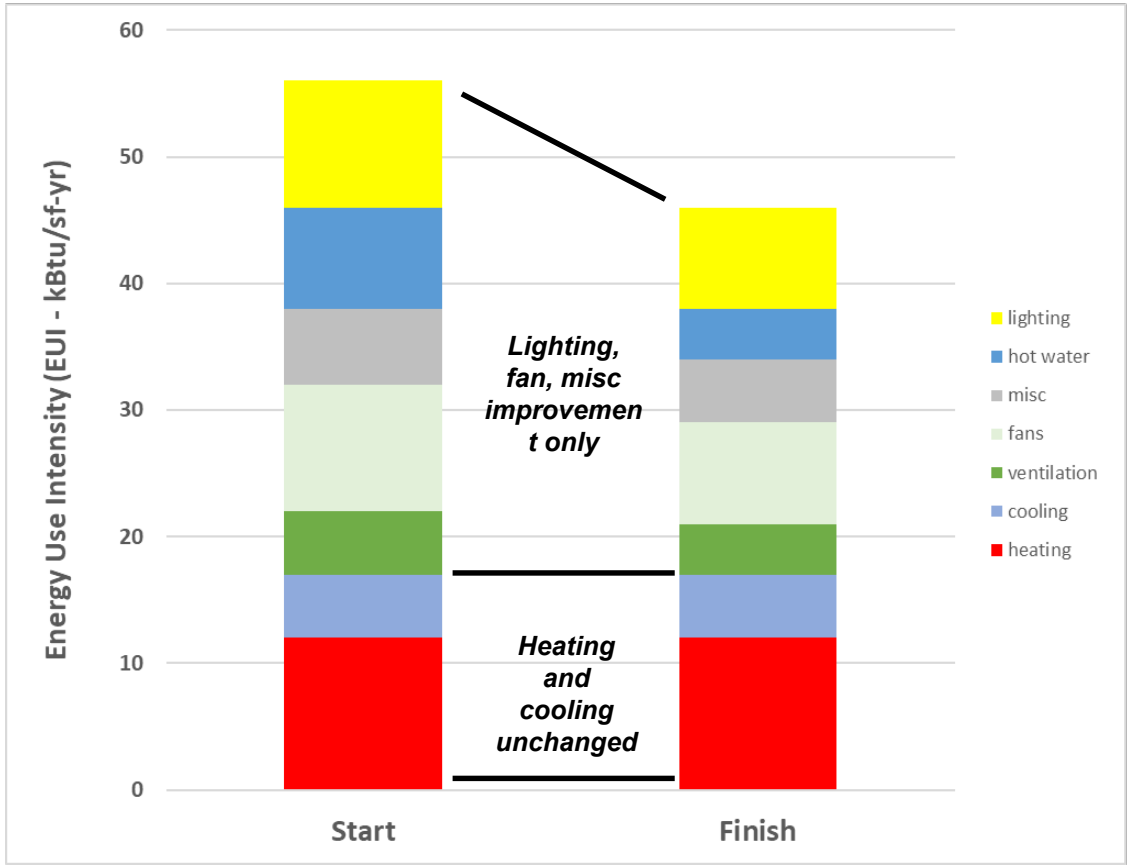
*Total annual energy **removed from** the building for space conditioning and conditioning of ventilation air, normalized by area (kBtu/sf-yr)*



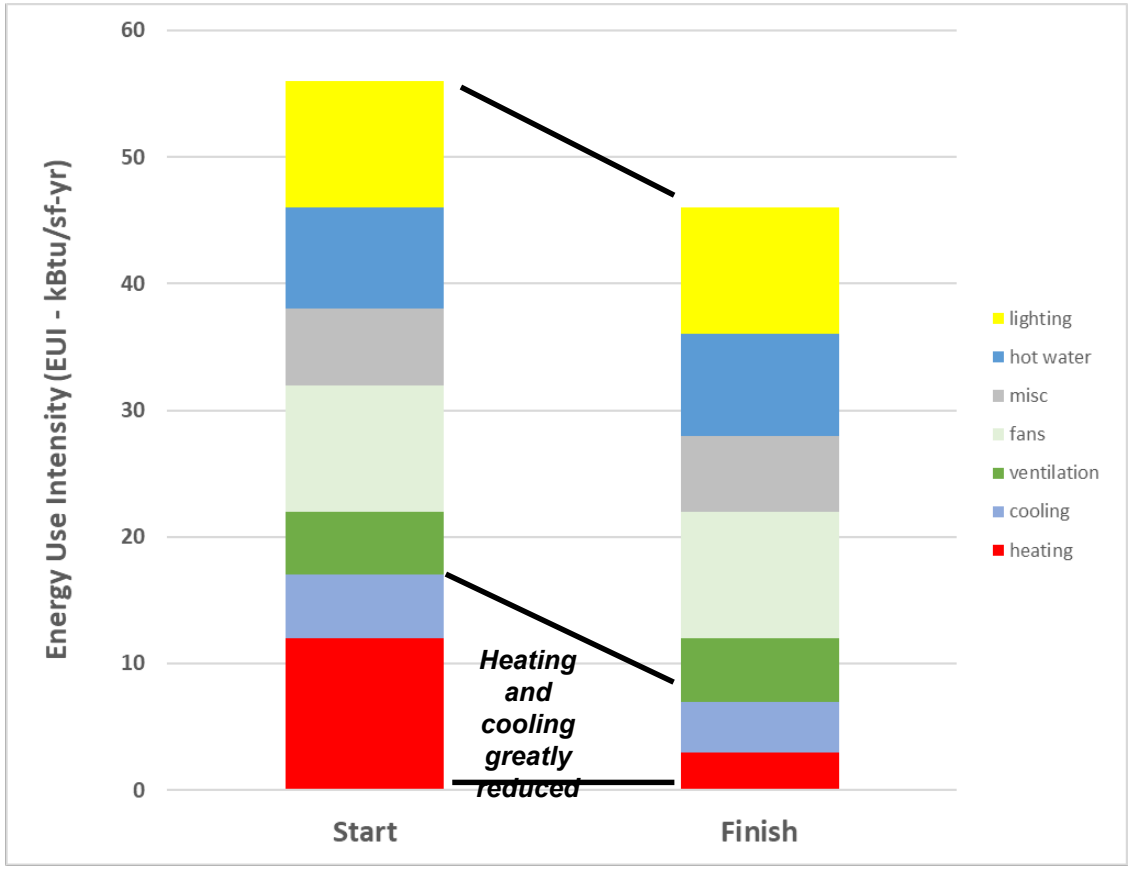
Important: even though they have the same units, TEDI is not the same as energy use intensity (EUI)

TEDI is demand while EUI is consumption

Why we TEDI?



Focus on <u>total energy reduction</u>:
Heating and cooling unchanged



Focus on <u>TEDI</u>:
Better envelope, air infiltration, external shading, lower emissions

A focus on total energy reduction does not necessarily yield better buildings.
A focus on TEDI more directly yields better buildings.

Why we TEDI?

Resilience

Electrification and emissions

Comfort and durability

TEDI focus and regulating thermal demands ensures designers prioritize envelope performance which helps ensure buildings that are resilient, easy to electrify, lower emissions, comfortable, and durable.

Other Key Modifications

Envelope backstop

Add'l stringency

Tenant spaces

Treated like new construction

Electrification of space heating

Highly ventilated: partial
Highly glazed: full

Mixed-use

Treat each use independently

EV ready parking

Wire 20% of new Business & Residential spaces
Wire 10% of spaces for other uses

Opt-in Specialized Energy Code

Specialized local adoption – Recommended timeline

Mar-Jun 2023

- **Spring Town meeting or City Council Vote to adopt**

July 1, 2023

- **6+ month phase-in period starts**

Jan 1, 2024

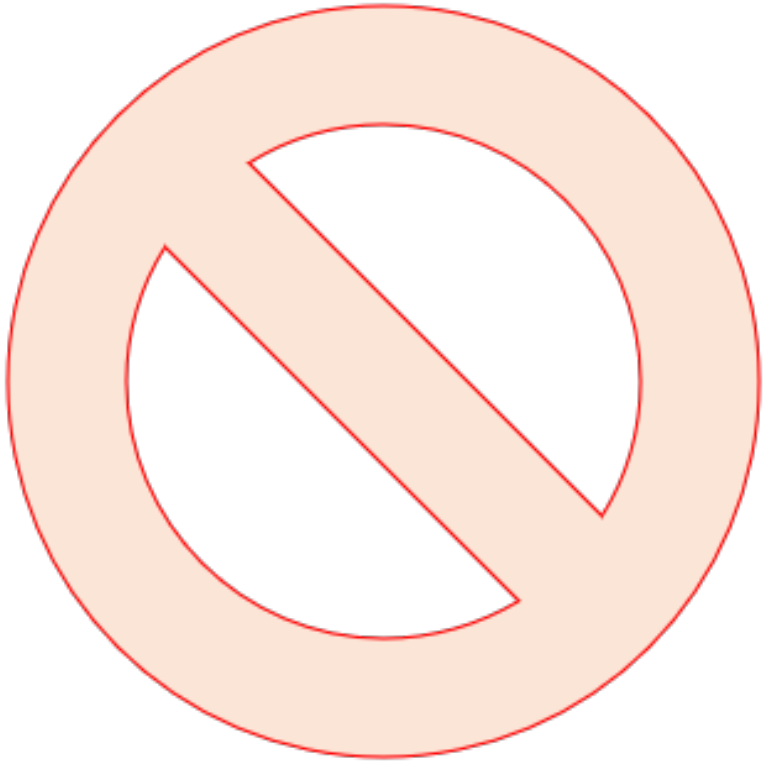
- **Specialized code takes effect**
- (HERS 0/42/45 or Passivehouse)

4 early adopter Cities effective July 1, 2023

Next group adoption effective Jan 1, 2024

MA Specialized code

What's in and What's NOT in



What is NOT in:

- A ban on the use of fossil fuels
- Embodied carbon accounting

What is in:

- Mandate for solar PV if using fossil fuels
- Mandate for electric EV chargers in all MA energy code options
- Mandate for prewiring for future electric uses

2023 MA Specialized code

Progress & Requirements

Areas of “readiness”

Required regardless of compliance path

Solar Readiness

Demand-response DHW

Electric Readiness

Electric Vehicle Readiness

Beyond Code

PHIUS

PHIUS CERTIFIED + ZERO ENERGY READY HOME U.S. DEPARTMENT OF ENERGY + EPA Indoor airPLUS + ENERGY STAR

IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH	phius CORE	phius ZERO
					Renewable Energy to Get to Zero
				Electrification Readiness	No Fossil-Fuel Combustion On-Site
				Electric Vehicle Readiness	Electric Vehicle Readiness
				Balanced Ventilation HRV/ERV	Balanced Ventilation HRV/ERV
			SOLAR READY Depends on climate	SOLAR READY ALWAYS	SOLAR READY ALWAYS
			Eff. Comps. & H2O Distrib	Eff. Comps. & H_2O Distrib	Eff. Comps. & H_2O Distrib
			EPA Indoor airPLUS VI	EPA Indoor airPLUS VI	EPA Indoor airPLUS VI
			Ducts in Condit. Space	Ducts in Condit. Space	Ducts in Condit. Space
		HVAC QI w/WHV	HVAC QI w/WHV	Micro-load HVAC QI	Micro-load HVAC QI
		Water Management	Water Management	Water Management	Water Management
		Independent HERS Verification	Independent HERS Verification	Independent HERS Verification	Independent HERS Verification
IECC 2012 Enclosure	IECC 2012 Enclosure	IECC 2012 Enclosure	IECC 2015/18 Encl./ES Win.	Ultra-Efficient Enclosure	Ultra-Efficient Enclosure
HERS 70-80	HERS 60-70	HERS 50-60	HERS 35-45	HERS 30-40	HERS < 0

RESIDENTIAL
Low Rise & Multi-family

Specialized vs Stretch code - Residential Low-Rise

Energy Source(s)	Home Size	Stretch code (July 2024)	Specialized Code (Jan 2024)
All Electric New Homes	Any Size home	HERS 45 or Passivehouse	
Mixed-Fuel New Homes	Under 4,000 sq ft	HERS 42	**+Solar PV (min 4kw) + wiring for electrification**
	4,000 sq ft and over	HERS 42	**+ Solar PV (to net-zero) + wiring for electrification**
	Any	Passivehouse option	**+ wiring for electrification**
Home additions & alternations	Any	Same as Stretch code	
Historic or Existing homes	Any	Energy Code not applicable	

Specialized Residential Code: Solar PV sizing

Solar required where there is a suitable solar-roof zone of 300 sq ft or more

Home Type	Solar required
All-electric	No
Passivehouse	No
Mixed-fuel <4,000 sq ft	**4 kW**
Mixed-fuel 4,000 sq ft +	**Enough for net-zero (8+ kw)**
other R-uses	0.75 W/sq ft (50% of commercial)

Specialized vs Stretch code – Multi-family

Building Type	Fuel Type	Stretch code (July 2024)	Specialized Code (Jan 2024)
New Multi-family (4+ stories & over 12,000 sf)	All Electric	HERS 45 or TEDI or Passivehouse	**Passivehouse**
	Mixed Fuel	HERS 42 or TEDI or Passivehouse	**Passivehouse + wiring for electrification**

Incentives

Federal 45L
Tax Credit +
Mass Save®

- Inflation Reduction Act
- 01/01/2023 – 12/31/2032 extended for 10 years
- The entity that financed the project claims the credit

45L	/ Home	/ Dwelling Unit	/ Dwelling Units Prevailing Wage
mass save® Savings through energy efficiency	All-Electric Single Family $ 15,000	Passive House Multi-Family $ 3,000	Passive House Multi-Family $ 3,000
ZERO ENERGY READY HOME U.S. DEPARTMENT OF ENERGY	$ 5,000	$ 1,000	$ 5,000

Specialized vs Stretch code – Commercial

Building Type	Fuel Type	Stretch code (July 2024)	Specialized Code (Jan 2024)
Schools, Offices, Municipal buildings	All Electric	TEDI or Passivehouse	
	Mixed Fuel	TEDI or Passivehouse	TEDI **+ Solar PV** or Passivehouse **+ wiring for electrification**
Other Commercial (over 20,000 sf)	All Electric	ASHRAE or TEDI or Passivehouse	
	Mixed Fuel	ASHRAE or TEDI or Passivehouse	ASHRAE **+ Solar** or TEDI **+ Solar** or Passivehouse **+ wiring for electrification**

Thank you!

Questions?

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